Oxford Dendrochronology Laboratory
Report 2010/44

THE TREE-RING DATING OF 6 PALACE STREET CAERNAFON, GWYNEDD (NGR SH 4785 6277)

Summary
Six samples taken from the trusses at first floor level by Michael Worthington resulted in two dated series – both being principal rafters from the same truss, both felled in **winter 1506/7**. As only one truss had been successfully dated, it was decided to take further samples at ground floor level. Three additional samples resulted in two further dated series, one from the ceiling beam and one from the north post of the same truss. The working site master created from the series dated thus far, allowed previously undated samples to be included, with the result that six series, representing timbers from the front and rear trusses of the three, were dated. Four timbers retained complete sapwood and were all felled in winter 1506/7, making construction most likely in **1506/7**, or within a year or two after this date.

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BACKGROUND TO DENDROCHRONOLOGY

The basis of dendrochronological dating is that trees of the same species, growing at the same time, in similar habitats, produce similar ring-width patterns. These patterns of varying ring-widths are unique to the period of growth. Each tree naturally has its own pattern superimposed on the basic 'signal', resulting from genetic variations in the response to external stimuli, the changing competitive regime between trees, damage, disease, management etc.

In much of Britain the major influence on the growth of a species like oak is, however, the weather conditions experienced from season to season. By taking several contemporaneous samples from a building or other timber structure, it is often possible to cross-match the ring-width patterns, and by averaging the values for the sequences, maximise the common signal between trees. The resulting 'site chronology' may then be compared with existing 'master' or 'reference' chronologies.

This process can be done by a trained dendrochronologist using plots of the ring-widths and comparing them visually, which also serves as a check on measuring procedures. It is essentially a statistical process, and therefore requires sufficiently long sequences for one to be confident in the results. There is no defined minimum length of a tree-ring series that can be confidently cross-matched, but as a working hypothesis most dendrochronologists use series longer than at least fifty years.

The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's *t*-test. The *t*-test compares the actual difference between two means in relation to the variation in the data, and is an established statistical technique for looking at the significance of matching between two datasets that has been adopted by dendrochronologists. The values of '*t*' which give an acceptable match have been the subject of some debate; originally values above 3.5 being regarded as acceptable (given at least 100 years of overlapping rings) but now 4.0 is often taken as the base value. It is possible for a random set of numbers to give an apparently acceptable statistical match against a single reference curve – although the visual analysis of plots of the two series usually shows the trained eye the reality of this match. When a series of ring-widths gives strong statistical matches in the same position against a number of independent chronologies the series becomes dated with an extremely high level of confidence.

One can develop long reference chronologies by cross-matching the innermost rings of modern timbers with the outermost rings of older timbers successively back in time, adding data from numerous sites. Data now exist covering many thousands of years and it is, in theory, possible to match a sequence of unknown date to this reference material.

It follows from what has been stated above that the chances of matching a single sequence are not as great as for matching a tree-ring series derived from many individuals, since the process of aggregating individual series will remove variation unique to an individual tree, and reinforce the common signal

resulting from widespread influences such as the weather. However, a single sequence can be successfully dated, particularly if it has a long ring sequence.

Growth characteristics vary over space and time, trees in south-eastern England generally growing comparatively quickly and with less year-to-year variation than in many other regions (Bridge, 1988). This means that even comparatively large timbers in this region often exhibit few annual rings and are less useful for dating by this technique.

When interpreting the information derived from the dating exercise it is important to take into account such factors as the presence or absence of sapwood on the sample(s), which indicates the outer margins of the tree. Where no sapwood is present it may not be possible to determine how much wood has been removed, and one can therefore only give a date after which the original tree must have been felled. Where the bark is still present on the timber, the year, and even the time of year of felling can be determined. In the case of incomplete sapwood, one can estimate the number of rings likely to have been on the timber by relating it to populations of living and historical timbers to give a statistically valid range of years within which the tree was felled. For this region the estimate used is that 95% of oaks will have a sapwood ring number in the range 11 – 41 (Miles 1997a).

6 PALACE STREET

One of very few timber-framed structures surviving within the walled borough of Caernarvon. The plan with cellar suggests a dwelling and shop range. The late-medieval timber-framed building survives behind a Georgian front. The range has four storeyed bays, with a cellar with broach-stopped beam under the front two bays. The building is box-framed with evidence for a jettied gable facing the street; a section of wall-framing with two tiered panels above and below the mid-rail in large panels survives. Three closed trusses survive and are all of the same type: jowled posts with up-braces to the tie-beam; central posts link tie-beam and collar. It is unclear if the range was part of a larger structure. The original room functions have been lost but one may speculate that the bay with cellar fronting the street was a shop, as it is today. No published account; detailed survey (2010) and other surveys in NMRW (NPRN 16637). (RFS/RCAHMW/2010)

SAMPLING

Sampling took place in two stages, with Michael Worthington taking samples from the trusses at first floor level in early 2010 and Martin Bridge coring timbers at ground floor level in August 2010. All the samples were of oak (*Quercus* spp.). Core samples were extracted using a 15mm diameter borer attached to an electric drill. They were numbered using the prefix **gwyd**. The samples were removed for further preparation and analysis. Cores were mounted on wooden laths and then these were polished using progressively finer grits down to 400 to allow the measurement of ring-widths to the nearest 0.01 mm. The samples were measured under a binocular microscope on a purpose-built moving stage with a linear transducer, attached to a desktop computer. Measurements and subsequent analysis were carried out using DENDRO for WINDOWS, written by Ian Tyers (Tyers 2004).

RESULTS AND DISCUSSION

Details of the samples and their locations are given in Table 1. Initially only **gwyd5** and **gwyd6** were dated, these being principal rafters from one truss, both felled in winter 1506/7. This left some question marks over the date of the whole structure, and for this reason further samples were taken in August 2010, from the ground floor timbers. Two of these series, **gwyd8** and **gwyd9** dated, with one of these retaining complete sapwood, and also being found to have been felled in winter 1506/7. These initial results were published in *Vernacular Architecture* **41**, p 115 (*in press*), and in the summary report for the project (Worthington and Miles 2010).

A new working site master was formed from the four dated series. Cross-matching with the previously taken series allowed another two series to be dated. The cross-matches shown between all the dated timbers shown in Table 2 contains some relatively poor matches, mostly resulting from the short sequences involved. The plots however showed good matching, and a 76-year long site chronology **CAERNFN1** was formed. Confirmation of the date of this sequence to the period 1431–1506 is shown by the results in Table 3, and the relative positions of overlap of the dated series are shown, along with their actual or interpreted felling dates in Figure 1.

Four timbers were felled in winter 1506/7, with a further two having likely felling date ranges incorporating this date. The dated timbers come from both the front and rear of the three extant trusses, showing that the whole present building was most likely constructed in 1506/7 or within a year or two after this date.

ACKNOWLEDGEMENTS

Michael Worthington undertook the initial sampling and sample measurement during 2009 and dated one of the samples at that time. Margaret Dunn and Richard Suggett both provided assistance on site and provided background information on the building. The owners were very kind in allowing sampling in what is a busy retail environment. We would also thank our fellow dendrochronologists for permission to use their data.

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Table 1: Details of samples taken from 6 Palace Street, Caernafon, Gwynedd. Trusses numbered from the back of the property (west).

Sample number	Timber and position	Dates AD spanning	H/S bdry	Sapwood complement	No of rings	Mean width mm	Std devn mm	Mean sens	Felling seasons and dates/date ranges (AD)
* **gwyd1a1**	Tiebeam to rear truss (T1)	1444-1487	1486	1	44	2.40	1.06	0.20	1499–1527
gwyd1a2	*ditto*	undated	-	12	12	-	-	-	-
gwyd1b	*ditto*	undated	-	14C	14	-	-	-	unknown
gwyd2	King post T1	undated	-	H/S	44	2.03	1.27	0.23	unknown
gwyd3a1	Tiebeam T2	undated	-	H/S	51	1.68	1.20	0.24	unknown
gwyd3a2	*ditto*	undated	-	15C	15	2.05	0.72	0.27	unknown
* **gwyd4**	Tiebeam T3	1448-1506	-	17C	59	2.86	1.21	0.34	Winter 1506/7
* **gwyd5**	Principal rafter S, T3	1431-1506	1488	18C	76	1.92	0.92	0.27	Winter 1506/7
* **gwyd6**	Principal rafter N, T3	1457-1506	1491	15C	50	2.45	0.81	0.24	Winter 1506/7
gwyd7	Ceiling beam T2	undated	-	3	32	2.65	0.96	0.33	unknown
* **gwyd8**	Ceiling beam T3	1437-1506	1488	18C	70	1.98	0.98	0.20	Winter 1506/7
* **gwyd9**	North post, T3	1448-1500	1490	10	53	2.27	1.00	0.26	1501–31
* =	included in site master **CAERNFN1**	**1431-1506**			**76**	**2.33**	**0.75**	**0.20**	

Key: H/S bdry = heartwood/sapwood boundary - last heartwood ring date; std devn = standard deviation; mean sens = mean sensitivity; C = bark edge present, winter felled; NM = not measured

Table 2: Cross-matching between the dated series forming site chronology **CAERNFN1**

	t - values				
Sample	**gwyd4**	**gwyd5**	**gwyd6**	**gwyd8**	**gwyd9**
gwyd1a1	2.8	3.4	2.3	3.7	2.3
gwyd4		3.3	3.3	3.1	2.4
gwyd5			4.2	6.2	5.2
gwyd6				2.0	3.7
gwyd8					2.8

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Table 3. Dating evidence for the site chronology **CAERNFN1,** AD 1431-1506 against individual site chronologies

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
Wales	Plas Mawr House	(Miles 1997b)	PLASMAWR	1360–1578	76	8.2
Wales	Branas-Uchaf, Llandrillo	(Miles *et al* 2010)	DENBY6	1388–1763	76	6.5
Wales	Rose and Crown, Gwydwn	(Miles and Worthington 2000)	GWYDWN	1411–1571	76	6.2
Wales	George and Dragon, Beaumaris	(Miles *et al* 2010)	ANGLSY1	1437-1540	70	6.1
Wales	Egryn Abbey	(Miles *et al* 2004)	LLANABR1	1433–1509	74	5.4
Shropshire	Church Farm, Ditton Priors	(Miles *et al* 2004)	DITTON5	1437–1578	70	5.4
Wales	Ucheldref Rhug, Corwen	(Miles *et al* 2010)	DENBY4	1373–1597	76	5.3
Staffordshire	Biddulph Old Hall	(Miles *et al* 2005)	BIDDULPH	1404–1524	76	5.3
Shropshire	Upper Lake, Westbury	(Miles and Worthington 2000)	UPRLAKE	1418–1546	76	5.3
Cornwall	St Martin's Church, East Looe	(Arnold *et al* 2006)	LOOASQ01	1363–1518	76	5.0

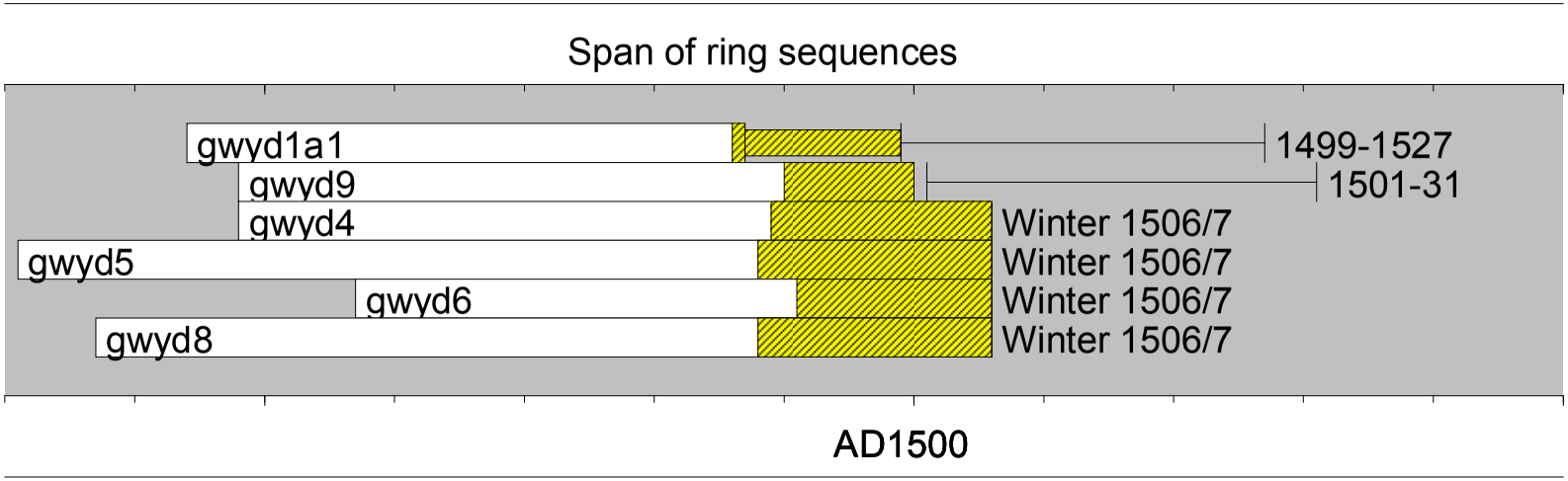

Figure 1: Bar diagram showing the relative positions of overlap of the dated timbers from 6 Palace Street, Caernafon. Yellow hatched sections represent sapwood rings, and narrow bar sections represent additional unmeasured or undated sections of the sample.

REFERENCES

Arnold, A. J., Howard, R, and Litton, C. D. (2006) *Tree-ring analysis of timbers from the Church of St Martin, East Looe, Cornwall*, **EH Research Dept Rep**, 46/2006.

Baillie, M.G.L. and Pilcher, J.R. (1973) *A simple cross-dating program for tree-ring research*. **Tree Ring Bulletin**, 33, 7-14.

Bridge, M. C. (1988) The dendrochronological dating of buildings in southern England, **Medieval Archaeology**, 32, 166-174.

English Heritage (1998) *Guidelines on producing and interpreting dendrochronological dates,* **English Heritage, London.**

Miles, D. (1997a) The interpretation, presentation, and use of tree-ring dates, **Vernacular Architecture**, 28, 40-56.

Miles, D H, (1997b) Working compilation of chronologies from Plas Mawr, Conwy, unpubl computer file PLASMAWR, Oxford Dendrochronology Laboratory

Miles, D. H. and Worthington, M. J. (2000) Tree-ring dates, **Vernacular Architecture**, 31, 90-113.

Miles, D. H., Worthington, M. J. and Bridge, M. C. (2004) Tree-ring dates, **Vernacular Architecture**, 35, 95-113.

Miles, D. H., Worthington, M. J. and Bridge, M. C. (2005) Tree-ring dates, **Vernacular Architecture**, 36, 87-101.

Miles, D. H., Worthington, M. J. and Bridge, M. C. (2006) Tree-ring dates, **Vernacular Architecture**, 37, 118-132.

Miles, D. H. and Bridge, M. C. (2010) Tree-ring dates, **Vernacular Architecture**, 41, in prep.

Tyers, I. (2004) *Dendro for Windows Program Guide 3rd edn*, **ARCUS Report,** 500b**.**

Worthington, M. J. and Miles, D. W. H. (2010) The Tree-ring Dating of Seven Buildings from Gwynedd, ODL unpubl report 2010/05